sustainable development commission

Sustainable Development Commission's response to the Department for Transport on Biofuels and the Renewable Transport Fuels Obligation

June 2006

Acknowledgements
The SDC wishes to thank Greg Archer (LowCVP) and Dr Ausilio Bauen (Imperial College London and E4tech), Aaron Berry (Department for Transport), and Rupert Furness (Department for Transport) for suggestions and comments on sections of the draft. However, this report represents the views of the SDC only.

Executive Summary

This report by the Sustainable Development Commission examines the role of biofuels in contributing to reductions in UK carbon emissions from road transport and the implications for sustainable development, using the Government's five principles as agreed in *Securing the Future* the UK's Sustainable Development Strategy (March 2005):

- Living within environmental limits
- Ensuring a strong, healthy and just society
- Achieving a sustainable economy
- Promoting good governance, and
- Using sound science responsibly

Biofuels are seen as having an increasingly important role to play in reducing carbon emissions from the road transport sector. The UK has a target of 5% of fuel sales from renewable resources by 2010-2011, and this is to be achieved through a Renewables Transport Fuels Obligation (RTFO). This was the main new measure for the transport sector in the UK Climate Change Programme 2006. Budget 2006 also suggested that targets for renewable fuels will increase post 2010-2011. Our analysis suggests that the use of primary crops as feedstocks to meet the 5% and higher targets presents a number of challenges for DfT and other government departments[1]. These are discussed in detail on the next page.

The SDC has three key recommendations for the 5% target:

1. the verification procedures, which accompany the mandatory reporting and proposed standards associated with the RTFO, must be rigorous.
2. the DfT must make it clear how the mandatory reporting framework will address complex issues such as the potential for deforestation and societal impacts
3. given the substantial differences in the greenhouse gas emission reductions offered by different biofuels, the RTFO should be designed with graduated incentives for lower carbon fuels from the outset. This would stimulate the development of second generation biofuels, which offer substantial carbon savings and make use of products which are currently non-productive. Waste products such as vegetable oils, forest residues and animal wastes could all play an important role. Making full use of this potential relies on:
    - new processing technologies which could become available in the short to medium term to extract the full energy value from these products[2];
    - clarifying the relative energy use and carbon saving potential associated with different end uses of products (heat or biofuel)[3];
    - establishing markets[4]; and,
    - making sure that costs are competitive, based on whole-life costs, including social and environmental costs[5].

The following challenges must be addressed before targets of greater than 5% are introduced.

---

[1] Chapters 6, 7, 8 and 9
[2] Paragraphs 3.4-3.6, 3.8-3.10, 7.25-7.26
[3] Paragraphs 9.15-9.16
[4] Paragraphs 8.13-8.14
[5] Chapters 7, 8 and 9

Verifying emission savings for different land uses:
Using some crops as biofuel feedstocks may not be the most effective way to reduce greenhouse gas emissions. A comparison of the greenhouse gas emissions from a range of food and non-food crops is necessary, taking into account different farming methods including organic and highly intensive methods to evaluate the importance of crop yields, greenhouse gases sequestered in the soil and the impact of inputs on the land. This is complex and the study should include a sensitivity analysis to account for potential over-estimation of the savings[6]. Such an evaluation would also need to include analysis of the carbon value of using biomass crops for heat, as opposed to using the crops to make biofuels (where such a choice is available)[7]. This could contribute to a strategic assessment for land use.

Verifying emission savings for imported feedstocks
For imported feedstocks, verifying the carbon emissions saved or avoided for different land uses discussed above remains important, but changes in land use could also be important. Increased production of biofuels as a cash crop could lead directly or indirectly to deforestation of tropical rainforest which would offset any greenhouse gas emission savings[8].

At present it is not possible to guarantee the purported 1 MtC saving associated with the UK 5% biofuels target[9].

Environmental impacts
Home grown crops could have negative impacts on biodiversity, particularly if biofuel crops are planted on set-aside land, which are currently part of Environmental Stewardship schemes. Excessive water demand for agriculture can be a potential problem in some areas of low rainfall, which is likely to become more of a problem in parts of southern England. Certain biofuel crops and processes require high volumes of water, which would divert resources from households and business, as well as putting increased stress on the natural ecosystem of the region[10].

An increase in demand for feedstock and fuels imported from abroad may result in deforestation and other habitat change, leading to biodiversity loss, water stress and changes in ecosystems[11].

Social impacts
Further evaluation of the social impacts and governance issues associated with overseas production of biofuels is required. Compliance with ISO 26000 could potentially be the means through which adverse societal impacts could be defined, thereby offering a means of identifying problematic fuel sources by country.

Markets work best when participants have access to all the relevant data. To overcome the challenges outlined above, the RTFO should require that information is available to

---

[6] Paragraphs 7.8-7.11, 7.16-7.21
[7] Paragraphs 9.15-9.16
[8] Paragraphs 7.12-7.15, 7.45-7.46
[9] Paragraphs 7.30-7.36
[10] Paragraphs 7.52
[11] Paragraphs 7.45-7.54

allow road transport fuel suppliers and the motoring public to make informed decisions about the source of the biofuels that they use.

The SDC’s recommendations are listed at the end of the report

1 Introduction

1.1 Certain crops and recycled elements of the food chain can be used to produce energy. This energy can be used in all sectors for example at present ethanol from sugar cane is used to power cars in Brazil, while saw mill residues are used for heating in Sweden. The distinction between crops used mainly for fuel substitutes ('mobile uses') and those that are burned for heat and/or power generation ('static uses') is becoming blurred - technology is being developed which allows the processing of woody and straw biomass into products for both mobile and static uses.

1.2 This note by the Sustainable Development Commission, arose out of a discussion with the DfT, and so focuses on transport uses. However, proposals to increase renewable transport fuel targets beyond 5% must take account of mobile and static uses of biomass crops and waste products.

1.3 This paper is divided into three sections: sections 2-5 provide background information on biofuels and consider the policy context, technologies and costs. Sections 6-9 give a sustainability assessment of biofuels, based on the UK's five principles of sustainable development. The final section (section 10) offers conclusions and recommendations for further work.

2 Policy Context

2.1 In the UK and internationally there is interest in increasing the production and use of biofuels for three main reasons: reduced greenhouse gas emissions compared with conventional transport fuel[1]; increased energy security and the potential to diversify rural employment opportunities.

2.2 The EU Biofuels Directive requires Member States to set targets for the substitution of petrol and diesel with biofuels. The Directive gives indicative targets of 2.00% in 2005 and 5.75% in 2010. The targets refer to energy content: biofuels contain less energy than the same volume of conventional fuels so sales volumes may need to be higher.

2.3 The UK has a target 5% of fuel sales from renewable resources by 2010-2011, to be achieved through a Renewable Transport Fuels Obligation (RTFO), and this was announced in November 2005. Budget 2006[2] set targets of 2.5% for the 2008-2009 period and 3.75% for the 2009-2010 period. These are significant increases from the 2005 target of 0.3%.

2.4 The RTFO requires transport fuel suppliers to ensure that a percentage of their sales in the UK are from renewable resources. No decisions have been taken on the detailed design of the RTFO, but the feasibility study mentions the importance of an environmental assurance scheme and the sustainability of supplies. Although biofuels are a relatively expensive way to reduce carbon dioxide emissions, they could be one of the most cost effective ways of reducing carbon emissions from the transport sector.

2.5 The Energy White Paper highlights the role that biofuels could play in securing long term carbon reductions and suggests that it could provide new opportunities for agriculture in the UK and globally. The paper suggests support for the development of bioethanol and biodiesel production from biomass such as from wastes, forestry residues, coppice crops and domestic wastes.

2.6 The UK currently supports the uptake of biofuels through the use of a 20 pence per litre fuel duty differential. The incentive for biodiesel was introduced in July 2002, and bioethanol in January 2005. In line with the government's commitment to provide a three year rolling certainty on alternative fuels the Budget 2005[3] confirmed that these fuel duty differentials would be in place until 2008.

3 Manufacture of biofuels and use in vehicles

3.1 This section summarises the main technologies used to produce biodiesel and bioethanol, and is based on a study by Woods and Bauen[4]. Information on the production of biofuels within the UK context is also provided.

<u>Manufacture</u>

Biodiesel

3.2 Biodiesel is produced using an esterification process based on feedstocks of either recovered waste vegetable oils and animal fats or oil extracted from seeds or oil-rich nuts. In the UK oil seed rape is a commonly used feedstock.

3.3 In the UK the world's largest processing plant for waste oils and fats opened in Motherwell, Scotland in 2005, with a production capacity of up to 50,000 tonnes of biodiesel a year. A biodiesel plant is due to open in Teeside this year, using rapeseed and palm oil as the feedstock. The plant will have a production capacity of 250,000 tonnes of biodiesel, and glycerine will also be produced. There are also local schemes - Bank Farm, Adlington produces 2000 litres of biodiesel a week from waste oils collected from customers in the catering trade. All the farm's delivery vans and several other vehicles run on this fuel[5].

3.4 In the future, gasification may be used to convert a much wider range of feedstocks into biodiesel. Potential feedstocks could include the wood and straw products of short rotation coppice, miscanthus, forestry, agricultural residues and some municipal solid waste streams. Gasification may be less 'conventional' energy intensive than current process techniques with biomass being used to generate the heat and power requirements of the conversion process. Fuels produced by gasification include:

1) Fischer Tropsch (FT) - biodiesel - which is produced by gasification of biomass, gas cleaning, detoxification and catalytic reformulation using Fischer Tropsch techniques.

2) DME (dimethyl ether) - which is produced through biomass gasification, gas cleaning and detoxification and catalytic reformulation to produce gaseous DME followed by liquefaction.

3.5 There is the potential for gasification technologies to be introduced in the medium term in the UK. For the FT-Biodiesel process, it is suggested that a first of a kind commercial plant could be in production by 2007/10[6]. However, it is also suggested that the introduction of commercial plants may take longer than anticipated[7].

3.6 DME is at the early laboratory stage. A full-scale commercial plant may be producing by 2015[8]. However, it is also suggested that since DME requires dedicated infrastructure and on-board storage and given that it is at the development stage, it is unlikely to capture a major share of the market.

Bioethanol

3.7 Bioethanol is currently manufactured using starch and cellulosic hydrolysis to produce simple sugars, which are then fermented using yeast in simple batch and continuous fermentation processes to produce ethanol. The principal feedstocks in the UK and rest of Europe are sugar beet and wheat, corn in the US and sugar cane in Brazil.

3.8 In the future cellulose/hemiscellulose hydrolysis could be used to derive ethanol from lignocellulosic materials. This would expand potential feedstocks for bioethanol to include wood and straw products. Commercial scale application of this technology depends on the development of cheap, effective enzymes. Once available, a full-scale commercial plant could be in operation within a few years. However, there are also concerns over the timescale and development of these enzymes[9].

Butanol

3.9 Bio-butanol can be produced from the fermentation of biomass. Feedstocks include sugar beet and agricultural by products. It is suggested that bio-butanol has an energy content closer to that of petrol than ethanol and so offers better fuel economy than petrol/ethanol blends[10]. British Sugar are currently constructing a bio-butanol plant in Norfolk[10].

3.10 Recommendation: DfT and other government departments to ensure that measures to encourage the uptake of biofuels help bring to market the technologies required to make full use of agricultural and forest residues as feedstocks. The RTFO should be designed with graduated incentives for lower carbon fuels from the outset. A volume-based RTFO is unlikely to incentivise carbon-savings.

<u>Use in vehicles</u>

3.11 Biofuels can be used in conventional vehicles. The potential for impact on the vehicle depends on the quality of the biofuel, the biofuel used, and the percentage blend. The EU Directive requires specific labelling at sales points for biodiesel and bioethanol blends in excess of 5%. The European Committee for Standardisation have produced a draft bioethanol specification for prEN 15376 for blending up to 5% in March 2006 and a workshop agreement on a 85% ethanol blend for adapted vehicles was published in 2005.

Biodiesel

3.12 Biodiesel has solvent properties that are both positive and negative. These properties can help keep engines clean and well running leading to an 'effective' energy content which is probably just a few percentage points below diesel. However, the solvent properties can also corrode the rubber sealants and as biodiesel ages, for example if left in an idle vehicle, it can degrade and form deposits that can damage fuel injection systems.

3.13 In the UK, diesel fuel offered for sale must meet European Standard BSEN590, while biodiesel must meet a separate standard EN14214. At blends of 5% biodiesel in ordinary diesel the BSEN590 standard will be achieved, provided the EN14214 standard is met. However at present time blends of greater than 5% biodiesel will not.

Many light vehicle manufacturers, currently only warranty their vehicles to run on up to 5% blends. A mandate from the EC to the European Commission for Standardisation, on the possibility of using ethanol in biodiesel production, is expected in early 2006.

Ethanol

3.14 Alcohols have a corrosive effect and at higher concentrations can degrade certain materials including plastic and rubber. This can damage the ignition and fuel system[11]. However, several car manufacturers are, currently, producing vehicles which are fully compatible with blends of up to 10% ethanol.

3.15 Low-level ethanol blends (5% and 10%) are widely used in the US, Canada, Australia and in many European countries, with no demonstrably significant differences in operability or reliability[12,13]. A 10% blend typically has a slightly higher octane than standard gasoline and burns more slowly and at a cooler temperature. At levels of greater than 10% ethanol some engine modifications may be necessary, though the exact level at which modifications are needed varies with local conditions for example climate. In Brazil, cars with minor modifications have operated satisfactorily on a 20% to 25% ethanol blend since 1994[14].

4 Cost of biofuels

4.1 This section compares fuel production costs for biodiesel and bioethanol from different feedstocks. Comparison is drawn with the fossil fuel equivalents but the prices given do not include external costs such as the climate change costs of fossil fuels: these issues are considered in the sustainability assessment.

4.2 The costs given in Table 4.1 are based on work by Bauen[15].

Table 4.1 Fuel production costs of different biofuel chains

Option	Feedstock	Country	Current costs[1,2] Pence per litre (£ per GJ)	2020 Projections
Gasoline			0.19[3] (5.93)	Dependent upon oil supplies
Diesel			0.21[3] (5.70)	
Ethanol	Sugar cane	Brazil	16.5 (7.70)	
	Corn	US	16.5-18.2 (7.70-8.49)	
	Grain	UK	0.22-0.31 (10.26-17.44)	
	Cellulosic crops	UK		0.18-0.42 (8.21-19.49)
Biodiesel	Rapeseed	UK	0.34-0.84 (10.26–25.65)	
F-T diesel	Coppice	UK		0.33-0.55 (9.23–15.39)

1 Figures were converted from US cents using a $1 = £0.57 exchange rate
2 If co-product revenues are considered then costs are at lower end of range
3 Assumes $50 a barrel

Notes: Figures for Ethanol from sugar cane, corn, grain and cellulosic crops are based on commercial production. There is some scope for cost reduction. Figures for ethanol from cellulosic crops and F-T diesel from coppice are based on cost projections for commercial plant based on engineering analysis.

4.3 The figures for gasoline and diesel in Table 4.1 are based on $50 dollars a barrel of oil. Higher oil prices will result in higher pence per litre production costs for petrol and diesel.

4.4 The UK currently supports the uptake of biofuels through a 20-p/litre rebate on fuel duty. The impact of this support on revenues to the Exchequer depends on the level of uptake. The cost is estimated to be £78 million if the uptake of biofuels was 0.8%,and £328 million if the uptake increased to 3.0%[16].

4.5 The UK government also provides financial assistance in the form of grants and allowances for infrastructure. A Regional Selective Assistance Grant of £1.2 million was used to help fund the Argent plant in Scotland. However, there are limitations with RSA in the UK because the qualifying regions are not necessarily those which are most suitable for the location of production facilities. At present the Government is holding talks with the biofuels industry about the potential for businesses to use Enhanced Capital Allowances (ECA), to write off costs of capital assets against taxable profits. Allowances would only be available for biofuel manufacturing installations which were capable of delivering good greenhouse gas savings, for example if CHP is included in the design, energy needs are met from renewable sources or second generation technologies are used.

5 Production

5.1 If biofuels are to become more important in the UK's transport fuel mix, then for security of supply reasons it is useful to know what feedstocks could be used and where they might come from. The potential feedstocks can be grouped into 3 main categories:

1) Waste products
2) Primary crops in the UK
3) Imported primary crops

5.2 The potential resource from waste products are shown in Table 5.1. In this Table, the estimates are based on a maximum contribution in 2050 and linear interpolation used to fit the intermediate points.

Table 5.1 Exploitable residue and waste biomass resources in the UK to 2050 (PJ)

	2010	2020	2030	2040	2050
Dry agricultural waste	19.8	39.6	59.4	79.2	99.0
Wood waste	11.2	22.3	33.5	44.6	55.8
Landfill gas	4.1	8.2	12.3	16.5	20.6
Municipal Solid Waste	57.7	115.3	173.0	230.6	288.3
Sewage sludge	5.8	11.5	17.3	23.0	28.8
Waste vegetable oil	7.5	14.9	14.9	14.9	14.9
Total	106.0	211.9	310.4	408.9	507.4

Source: E4Tech (2003)[17]

5.3 Energy is used to convert these potential exploitable residues into biofuels. The contribution to overall fuel demand is therefore lower than suggested in the tables. The Biofuels Research Advisory Council, suggest a 40% conversion factor, with the use of current technology, and a 55% conversion factor, with the use of future technologies. The potential for biofuel production from residue and waste biomass resources is illustrated in Table 5.2.

Table 5.2 Potential for biofuels production from residue and waste biomass resources (PJ)

	2010		2020		2030		2040		2050	
	Conversion factor									
	40%	55%	40%	55%	40%	55%	40%	55%	40%	55%
Dry agricultural waste	7.92	10.89	15.84	21.78	23.76	32.67	31.68	43.56	39.6	54.45
Wood waste	4.48	6.16	8.92	12.27	13.4	18.43	17.84	24.53	22.32	30.69
Landfill gas	1.64	2.26	3.28	4.51	4.92	6.77	6.6	9.08	8.24	11.33
Municipal Solid Waste	23.08	31.74	46.12	63.42	69.2	95.15	92.24	126.83	115.32	158.57
Sewage sludge	2.32	3.19	4.6	6.33	6.92	9.52	9.2	12.65	11.52	15.84
Waste vegetable oil	3.00	4.13	5.96	8.20	5.96	8.20	5.96	8.20	5.96	8.20
Total	42.40	58.30	84.76	116.55	124.16	170.72	163.56	224.90	224.90	279.07

5.4 The potential contribution from UK primary crops is shown in Table 5.3. This is based on work by Woods and Bauen with assumptions provided in Annex 1. Values do not account for conversion of the resource to fuel. The actual contribution to fuel would therefore be lower.

Table 5.3 The potential for use of primary crops

	Current (PJ)	Land area (ha)	Future (PJ)	Land area (ha)
Oilseed rape	6.34	80,000	42.53	537,000
Oilseed rape (set-aside Land)			53.96	681,000
Sugar beet (land currently used for food purposes)			42.64	205,000
Wheat (currently exportable wheat)			41.65	350,000
Lignocellulosic (short rotation coppice and set-aside land)			123.26	681,000
Lignocellulosic (miscanthus and set-aside land)			183.65	681,000
Total (set-aside land not used)			126.82	
Total (set-aside land used for oilseed rape)			180.78	
Total (set-aside land used for short-rotation coppice)			250.08	
Total (set-aside land used for miscanthus)			310.47	

5.5 International trade in bioethanol and biodiesel is well established and in the UK the majority of biofuels sales are currently imports[18]. At present, there is a cost advantage to imports; however UK producers are confident that their products will be competitive.

5.6 UK road transport currently uses approximately 1600 PJ per annum. Research by E4Tech suggests that the UK could, assuming a rapid uptake scenario, produce 10% of its own fuel needs from biofuels in 2010 and 20% in 2020. In the UK primary crops are currently best positioned to meet short-term needs, with incentives required to allow feedstocks based on waste products to realise their market potential.

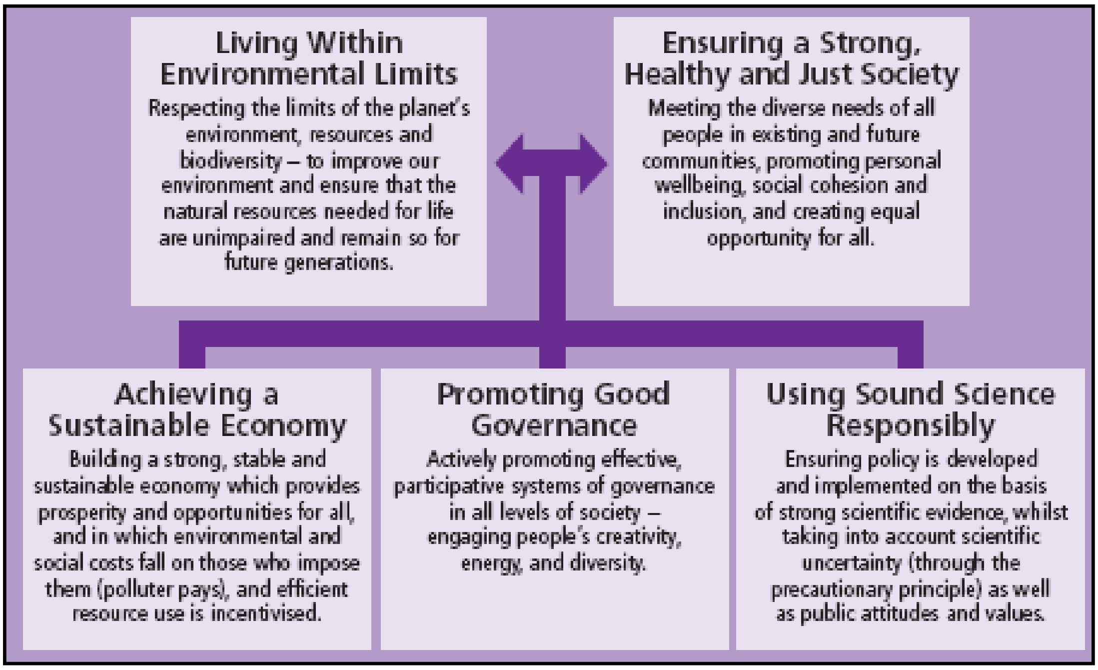
5.7 Alternative uses of the crops and waste products need also to be considered. For example, for lignocellulosic crops such as willow, it may be more efficient and cost effective to convert the wood into energy through direct combustion.

5.8 Furthermore it is important to assess the impact of biofuel production on sustainability whether through the use of imports, home grown feedstocks or waste products and we assess these in the following sections

6 Sustainability assessment

6.1 The UK Sustainable Development Strategy[19] and Framework[20] gives five key principles of sustainable development that form the basis for policy in the UK (Figure 6.1.)

Figure 6.1 UK principles for Sustainable Development



"These principles form a basis for sustainable development policy in the UK. For a policy to be sustainable, it must respect all five principles. We want to achieve our goals of living within environmental limits and a just society, and we will do it by means of sustainable economy, good governance and sound science."

6.2 Within the strategy there are four priority areas for immediate action: sustainable consumption and production; climate change and energy; natural resource protection and environmental enhancement; and sustainable communities. The first three of these are particularly relevant in considering the potential use of biofuels.

6.3 The following sections use the two goals and the other principles, in particular achieving a sustainable economy, to assess the key issues associated with the use and the production of biofuels. The emphasis on 'sustainable economy' arises mainly because of the policy objective of energy security and potential benefits to the rural economy.

7 Living within Environmental Limits

The main environmental limits for biofuels are greenhouse gas emissions, biodiversity and air, soil and water quality. These are discussed below.

Greenhouse Gas emissions

7.1 A key objective for the introduction of biofuels is the potential to reduce emissions of greenhouse gases. UK targets include:

- The Energy White Paper aim of a 60% reduction in carbon dioxide emissions by 2050
- A Kyoto Protocol commitment of a 12.5% reduction in greenhouse gas emissions from baseline emissions in 1990 by 2012
- Domestic goal of a 20% reduction in carbon dioxide emissions by 2010[21]
- A Public Service Agreement target based on the last two targets (shared between DfT, Defra and DTI)[22]

7.2 The UK Climate Change Programme 2006 highlights the need for all sectors to contribute to emission reductions. Road transport currently produces around 22% of carbon emissions and this contribution is expected to increase in the short to medium term.

7.3 The carbon savings associated with biofuels depend on the carbon emissions incurred over the full life-cycle of the fuels for example in land use change, the use of fertilisers, irrigation, production methods, and transport to the point of use. The DfT in their analysis for the RTFO assumed a 50% carbon saving.

7.4 Analysis[23] based on several studies of the greenhouse gas emission reductions available from biofuels, is shown in Table 7.1.

Table 7.1 Greenhouse Gas % of conventional equivalent from different feedstocks comparison of research results

			GHG % of conventional equivalent		
Feedstock	Process	Range	Sheffield Hallam University	Concawe /Eucar/JRC	Imperial College
Oilseed rape	Esterification	Low	45%	38%	20%
		Mid	47%	62%	36%
		High	49%	84%	52%
Recycled vegetable oil	Esterification	Low	13%		2%
		Mid	15%	N/a	10%
		High	17%		18%
Ligno cellulosics	Fermentation /hydrolysis	Low	14%	22%	5%
		Mid	16%	25%	27%
		High	19%	34%	49%
Sugar beet	Fermentation	Low	46%	56%	37%
		Mid	49%	59%	74%
		High	53%	63%	111%
Wheat	Fermentation	Low	33%	57%	32%
		Mid	36%	85%	64%
		High	38%	106%	95%

Source: (CFT, IEEP, NSCA, 2004)
Notes
lignocellulosics = wheat straw in SHU, wood in CEJ and IC
Percentages are relative to conventional fuel (ie esterisation: diesel, fermentation: petrol)
Percentages are of fuel-cycle total weighted greenhouse gas (GHG) emissions
IC mid-points are mathematical mid-point of Low and High
Sheffield Hallam[24] on a well to tank basis and used a price allocation method
Concawe/ Eucar/JRC[25] analysis on a well to wheels basis (i.e. including the engine efficiency of the vehicle) and used a substitution allocation method
Imperial College undertook analysis on a well to tank basis and did not allocate any of the co-products.

7.5 The analysis measures total fuel-cycle weighted greenhouse gas emissions of various biofuels relative to those of a corresponding conventional fuel obtained from crude oil. This allows well-to-wheel[12] and well-to-tank results to be compared on a similar basis. The analysis shows that different research approaches, including the allocation method used and the remit of the project, provide different greenhouse gas reduction figures.

7.6 Further work has been undertaken by the authors of the three studies[26], and a consensus on well to wheels evaluation for conventional UK biofuels has been achieved. In developing this consensus the energy demand and greenhouse gas emissions associated with producing bioethanol from wheat was assessed. Here the results were affected by the use of by-products and the heat and power generation scheme used in the ethanol plant. Further findings from the study are discussed in the following sections.

7.7 Although a consensus on the well to wheels evaluation of biofuels has been reached, there are a number of further and associated issues that need to be taken into consideration when examining the greenhouse gas emissions associated with biofuels. These are discussed below.

The impact on soil greenhouse gas balances

7.8 Life cycle analysis is used to calculate the carbon emissions offered by biofuels. Typically this includes greenhouse gas emissions associated with the manufacture of fertilisers, production methods and transport to the point of use. However, consideration also needs to be given to the impact that agricultural practices have on the land. First, the application of fertiliser adds nitrogen to the soil, not all of which is used by the crop, some being transformed by soil microbes into nitrous oxide (N_2O). Nitrous oxide has a Global Warming Potential (GWP) of 310 times CO_2. The emissions of nitrous oxide associated with nitrogen addition are strongly influenced by complex interactions between soil type, climate, plant growth and farming methods. Second, the addition of synthetic fertilisers also impacts on soil methane oxidation. Atmospheric methane is broken down by bacterially enabled oxidation processes in the soil. The application of synthetic fertilisers impacts on the oxidation process. Methane has a GWP of 21 times CO_2. Finally, fertilisers also acidify the soil, requiring the regular application of lime, the production of which produces more carbon dioxide[13].

7.9 The soils and waste unit of the Institute of Environment and Sustainability of DG-Joint Research Centre (Ispra) has developed a database-model Greenhouse Emissions from Agricultural Soils in Europe (GREASE) to calculate the

[12] Well to wheel includes energy and greenhouse gas emissions associated with the production and transport of the fuel (well to tank) and the use of the fuel in the vehicle (tank to wheel).

[13] Lime is generally produced by heating limestone ($CaCO_3$) to release CO_2 and produce lime (CaO) – emissions from heating depend on the fuel used, but those from the chemical reaction are unavoidable

impact of N_2O on field emissions. For sugar beet the contribution of N_2O is 27%, for wheat 42% and rapeseed 46%. The GREASE model, which is relatively new, was used in the well to wheels consensus study; and to help produce the data in the Concawe/Eucar/JRC study in Table 7.1. The Sheffield Hallam and Imperial College study do not use the model. N_2O emissions from areas outside of Europe are identified as a potentially contentious area where further research is necessary[27].

7.10 The impact of fertiliser on the oxidation process of methane and the carbon dioxide production associated with the application of lime also need further consideration. Inclusion of these impacts could reduce the potential emissions savings.

7.11 Recommendation: The DfT must validate the assumption for the RTFO that biofuels will result in a 50% reduction in emissions, based on whole life cycle analysis.

Impact of land use changes overseas

7.12 If the growth of biofuels results in deforestation, or land use changes from other high carbon density ecosystems such as grasslands, then this will offset greenhouse gas emissions savings, for at least 50 years[28]. In the Partial Regulatory Impact Assessment carried out for the DfT the risk of deforestation is briefly mentioned but not appropriately quantified.

7.13 It is often difficult to establish a direct relationship between deforestation and other land use changes and the growth of biofuel crops. After land is deforested it may be used for a number of different purposes, e.g. coffee production, before use for biofuel crops. It has been suggested that one way to prevent deforestation is to determine whether areas used for biofuels have been deforested within a specific time frame. For example, crops grown after 1990 on land that has been deforested could not be used for instance. However, this would not capture the indirect displacement of forest for biofuel crops. For example, some countries might use existing agricultural land to grow biofuel (as a cash crop), resulting in deforestation to make way for domestic food production. Deforestation must be prevented by appropriate national legislation that is enforced.

7.14 These effects could be captured for example through periodic assessments of land uses in supply countries to assess the impact of the growing market for biofuel crops.

7.15 Recommendation: measures to ensure that either direct or indirect deforestation does not occur should be an essential component of the RTFO.

The potential role for organic/less intensive farming

7.16 Mortimer et al[29] suggest that less intensive production of biodiesel results in CO_2 savings. Methods identified include low nitrogen cultivation of oilseed rape and the use of rape straw as an alternative heating fuel in the processing of the biodiesel.

7.17 The use of less intensive and organic farming methods whether to grow biofuels or other crops could be beneficial in terms of greenhouse gas emission reduction and wider environmental objectives. Further, growing conventional crops less intensively may result in greater greenhouse gas emission savings than the production and use of biofuels.

7.18 Organic farming is based on the use of organic matter, which builds up carbon in the soil. Data from the Rodale Institute Farming Systems[30] trial found that over a 22 year period organic grain production systems increase soil carbon between 15% and 28%. Moreover soil nitrogen in the organic systems increased between 8 to 15%. Intensive systems showed no significant increases in either soil carbon or nitrogen in the same time period.

7.19 It is possible that growing biofuels crops organically would bring greater carbon benefits than using conventional methods. UK trials of the agronomy of organic sugar beet, funded by the British Beet Research Organisation[31], indicates that good yields of beet at economic costs are feasible, although there were issues over pest infestations at one of the three trial sites.

7.20 For ligno-cellulosic crops a clearer understanding of the inputs required is necessary. It may be easier to grow willow rather than miscanthus in a less intensive manner.

7.21 Recommendation: Future research to clarify the potential greenhouse gas savings associated with:

i) Production of biofuels using a variety of farming methods (organic to intensive)
ii) Organic and non-organic methods for all crops (food and non-food)

The treatment of co-products

7.22 When biofuels are produced there are often co-products, such as straw, rape meal and glycerol from oilseed rape for biodiesel. Straw can be used as a heating fuel, rape meal as animal feed and glycerol for use in the chemical industry. The way that by-products are used affects the greenhouse gas emissions and energy use associated with biofuel production.

7.23 It should be noted that the production of certain co-products may involve high energy and chemical use and the use of lower energy and chemical inputs can affect the quality of the co-product. It is therefore important that the energy used in the production of co-products is accounted for.

7.24 Recommendation: Energy requirements and emissions should be allocated to co-products, and emissions saved by use of these co-products should also be considered.

The role for new technologies

7.25 New technologies including gasification and cellulose / hemicellulose hydrolysis are necessary to maximise greenhouse gas emission savings and make full use of potential feedstocks. Early development and uptake of technologies is important in reducing costs. With government backing these technologies could be available by 2010.

7.26 Recommendation: The DfT must assess the impact of the RTFO on the development and uptake of new technologies. Steps must be taken to ensure that the appropriate policy and financial support is available for those technologies that will make full use of potential biofuel feedstocks and save most carbon. This is the basis of our recommendation that the RTFO is graduated to reward greater carbon savings.

7.27 Wet biomass materials including pig and cattle slurries, sewage sludge and food wastes are potentially significant sources or renewable energy[32]. Anaerobic digestion (AD)[14] is identified as a potential cost and energy effective means of using this energy source. However, barriers include the limited availability of biogas vehicles and the lack of a UK-wide certification standard for digestate. The Biomass Task Force report to Government recommends that the Government carries out an economic and environmental assessment of the potential of AD biogas as an alternative fuel to replace diesel.

The heat and power system used in the biofuels plant

7.28 The heat and power system used makes an important contribution to overall emissions. Combined heat and power and fuelling the biofuel production process through the use of by-products such as straw can significantly reduce the greenhouse gas emissions. By products could also be used to encourage the development of small scale and distributed electricity generation as recommended in the Energy White Paper (2003). The actual use of by-products for energy and non-energy uses will depend on the markets and commercial incentives available.

7.29 Recommendation: to make full use of the opportunity through the expanding biofuels market to encourage the development of small scale and distributed electricity generation as recommended in the Energy White Paper (2003)

Validation of greenhouse gas emission savings

7.30 A key policy objective associated with the introduction of biofuels is a reduction in greenhouse gas emissions. It is essential therefore that there is a means of verifying the savings, this is particularly important with regard to the introduction of a Renewable Transport Fuels Obligation and the anticipated annual 1 MtC saving.

7.31 Greenhouse gas accreditation is one method - the fuel's carbon intensity is calculated from verified process data, provided by the fuel producer / supplier or the use of default values. A detailed report by E4Tech, ECCM and Imperial College highlights the following points.

- Linking greenhouse gas certification to a Renewable Transport Fuels Obligation could be legally justified under the EU and World Trade rules.
- The costs of data collection and verification would not adversely affect the economics of biofuels production.
- Avoiding deforestation should be considered as part of GHG certification.
- A scheme could be developed and piloted within 18 months.
- Some form of Carbon assurance should be linked to RTFO from the outset.

7.32 A greenhouse gas accreditation scheme could also help ensure that production methods were less greenhouse gas intensive. In Brazil,

[14] the breakdown by micro-organisms of organic materials into biogas and liquid and solid digestates

nitrous oxide is emitted in the manufacturing process[33], and steps, which could be taken to reduce these emissions, are not being implemented. Pre-harvest burning procedures occur in Brazil and can also lead to increases in greenhouse gas emissions.

7.33 Any transaction costs associated with the use of actual data could be offset through graduated incentives in the RTFO. This could be structured to encourage the use of more reliable, actual data rather than generic default values.

7.34 Mandatory reporting is suggested, by Climate Change Capital[34], as an alternative method to accreditation. Here, it will be the responsibility of the suppliers to provide a report on the carbon emissions associated with the biofuels they use. Emission reductions are therefore dependent on suppliers concerns over carbon reduction. This may be influenced by corporate social responsibility requirements and pressure from NGO's.

7.35 The SDC's understanding of the current proposed methodology for the RTFO scheme is as follows:

- Mandatory reporting of greenhouse gas emissions and wider environmental and sustainability issues will be a requirement of the RTFO.
- The RTFO will specify reporting criteria, but not minimum performance standards.
- A biofuels sustainability standard will be provided: with acceptable and gold standard performance, but fuels suppliers are not obliged to operate to these standards. If the fuel supplier complies with the standard then certification will be awarded through a standard certification body.
- The fuel suppliers reports will have to be verified.
- Responsibility for compliance will carry through the supply chain and the information provide by the biofuel producer, and the crop supplier will also have to be verified
- There is the potential, in the longer term, for an incentive scheme to be linked to the greenhouse gas emissions of the biofuels. With lower emission biofuels rewarded.

7.36 Recommendations: The DfT must ensure that complex issues for example the potential for deforestation are addressed within RTFO mandatory reporting. Incentives linked to the greenhouse gas emissions of biofuels must be introduced from the outset.

The use of waste vegetable oils

7.37 Waste vegetable oils offer significant greenhouse gas savings. They are a currently available, low cost source of biofuels which could provide 1% of UK road transport energy use. However, if not properly processed or blended they can result in poor air quality. Measures to encourage the use of this feedstock are necessary while making sure quality standards are met.

7.38 Recommendation: DfT and Defra to promote the uptake of waste vegetable oils as biofuels provided they meet air quality objectives.

Biodiversity

7.39 Biodiversity is defined as the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part[35]. Biodiversity is essential for the functioning of ecosystems that underpin the services that ultimately affect human well-being. These services include *provisioning services* such as food and timber; *regulating services* such as regulation of climate, and floods; *cultural services* such as aesthetic enjoyment; and *supporting services* such as soil formation and nutrient cycling.

7.40 Maintaining biodiversity could be seen as one means of minimising the environmental impact of, for example climate change. Biodiversity has economic benefits, current research suggests that the cost of biodiversity loss can outweigh the benefits from the activities that have lead to the loss. Furthermore globally the costs and risks associated with biodiversity loss are expected to increase and fall disproportionately on the poor.

7.41 The UK has a number of national and international obligations to protect biodiversity including:

- Convention on Biological Diversity[36] – aim of strategic plan " to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and all life on earth"
- EU Habitats Directive[37] – main aim "to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements"
- EU Birds Directive[38] – seeks to protect, manage and regulate bird species living in the wild
- Domestic legislation on the protection of wildlife and habitats including protected areas[15]
- Public Service Agreement target (Defra) – care for our natural heritage, make the countryside attractive and enjoyable for all and preserve biological diversity. This includes the commitment to reverse the long term decline in the number farmland birds by 2020.

The impacts of biofuels on biodiversity are considered below.

UK context - Biodiversity loss associated with removal of set-aside

7.42 The impact of growing biofuels on biodiversity depends on the land use that is replaced, the crop, and how intensively the crop is managed. The most significant impacts on the environment in the UK are likely to occur if biofuel crops are established on set-aside[16] land. Many of these areas have acquired a rich diversity of species as a result of non-intervention management, in contrast to general declines in species-richness on more intensively managed land. Set-aside may be of particular benefit to farmland birds. Farmland bird numbers are significantly greater on set-aside land compared with a

[15] e.g. Wildlife and Countryside Act (1981), Sites of Special Scientific Interest and associated legislation/sites in Scotland and Northern Ireland.

[16] In the UK, under the Common Agricultural Policy, farmers are able to claim payments in return for setting-aside land from agricultural production, or only using such land for a limited number of non-food or animal feed uses. This land is known as 'set-aside'.

random farmland landscape[39] and crop fields, probably because of the higher levels of invertebrates found on set-aside land[40].

7.43 Comparing with potential biofuel crops suggests that although oil seed rape can support a large number of invertebrates compared with other crops[41] and provides habitat and food for a number of bird species, and sugar beet and wheat provide breeding sites and a food source of food for some birds,[42], all three crops are less important for biodiversity than set-aside.

7.44 **Recommendation: For a biofuels policy to be sustainable impacts on biodiversity need to be addressed and minimised. Care is required to make sure that the uptake of biofuels crops does not unpick the environmental and conservation objectives now built into agricultural and forestry objectives.**

International context – the potential impact of deforestation

7.45 At the international level concerns have been raised about the impacts on biodiversity of ethanol production in Brazil, palm oil production in Indonesia and Malaysia[43]. Deforestation, and other habitat change are identified as one of the most important direct drivers of biodiversity loss and change in ecosystem services. Historically the production of biofuels can be related to the loss of rainforest. It is acknowledged that the Brazilian ethanol production programme contributed to the destruction of parts of the Atlantic rain forest in São Paulo[44]. In Malaysia 33%, and in Indonesia 66% of oil palm plantations involved forest conversion. The WWF[45] have highlighted concerns that increased soy for biodiesel purposes may lead to the expansion of agriculture into ecologically sensitive areas in the Amazon and Cerrado. Furthermore where biofuels are grown on land that is currently used for different crops or grazing cattle, there is the potential for indirect displacement of crops leading to further deforestation. A key issue is that of data availability with regard to where existing crops are grown and future areas for biofuel growth.

7.46 **Recommendation: a better understanding of the impact of increased demand for biofuels would have on deforestation or other loss of biodiversity is an essential part of any scheme to promote the uptake of biofuels.**

International and national issues - agricultural practices impacts on biodiversity and other environmental aspects

7.47 Agricultural practices such as the use of fertilisers and pesticides can also reduce biodiversity. Less intensive use or organic farming needs to be explored. Organic farming can increase the level of biodiversity, compared with conventional crops[46].

7.48 The impact on agricultural landscape will vary depending on the biofuel crop, and the land use it is replacing. For example in the UK it is suggested that in the longer term the plantations associated with lignocellulosic crops will need to be carefully planned to fit into existing landscapes. Non-native grasses such as miscanthus may have a more significant visual impact.

7.49 The growth and production of biofuel crops also has air quality implications. The ammonia used in some fertilisers can negatively impact on air quality. In Brazil, pre-harvest burning associated with sugar cane-crops (to promote pest control and lower harvesting costs) has led to air pollution. Approximately 75% of São Paulo's pre-harvest treatment is done through burning[47]. Mechanisation can replace burning but has been opposed because of job losses. Air pollution caused by forest and peat fires is also cited as a potential problem in palm oil production.

7.50 In the UK research suggests that the negative impacts of cropping can be moderated by the use of different management practices. Sustainable farming techniques are implemented at a whole field basis and measures such as spring cropping can be used to provide over winter stubbles as a food source for wild birds.

7.51 The addition of new cash crops in some countries may exacerbate water stress issues, particularly where the crops require significant volumes of water relative to local supply and where the economic incentive may override an adequate assessment of the environmental and social impacts associated with the change in land use. This could frustrate the achievement of the UN Millennium Development Goals to eradicate extreme poverty, hunger and to ensure environmental sustainability.

7.52 The use of intensive agricultural practices associated with biofuel crops could result in pollution of water bodies for example the contamination of surface water due to growth in sediment and agrochemical inputs. Some crops also require large volumes of water, which can lead to problems of water stress. These problems are serious in low rainfall areas such as the East and South of England. UK Climate Change Impact Programme climate change scenarios indicate that in future this will be an increasingly serious problem along the east coast of England.

7.53 The use of crop and forest residues for biofuels may impact on ecosystem functioning. For example, if all of the straw is removed, fields require significantly greater inputs of fertilisers. This could result in a 30% increase in GHG emissions from agriculture. The removal of forest residues could impact on soil quality, but it is suggested that If 30% of residues are left in-situ then soil quality will be retained.

7.54 **Recommendation – production of biofuel crops should be guided by local environmental limits including those for soil, air and water quality, landscape change and water resources. Further work is required to clarify these limits. The use of an accreditation scheme will help to reduce impacts at the International and National Level.**

Air Quality Impacts from the Use of Biofuels

7.55 Air quality pollutants from fossil fuels include benzene, carbon monoxide, particulates, sulphur dioxide, and ozone. These can impact on health and be detrimental to buildings. The UK has the following policies:

- An air quality strategy with objectives for reduction for eight pollutants,
- A PSA target on air quality which

is shared by DfT and Defra

The use of biofuels in vehicles offers potential positive and negative impacts.

7.56 Biodiesel blends at 5% could offer reductions in particulates[48]. Where 100% vegetable oil was tested in vehicles there were negative air quality impacts, including a 100 per cent increase in PM10 and a 420 per cent increase in carbon monoxide with the worst performing vehicle.

7.57 Bioethanol research for the DfT suggests that, for blends of 10%, significant emission reductions for particulates and CO can be achieved. However, EEDA suggest that bioethanol produces few air quality benefits, though a reduction in CO from older car engines is mentioned[49]. The research for the DFT also suggests that for some vehicles tests acetaldehyde emissions were significantly increased.

8 Ensuring a strong, healthy and just society

8.1 This principle is about meeting the diverse needs of all people in existing and future communities promoting personal wellbeing, social cohesion and inclusion and creating equal opportunity for all.

8.2 Social Accountability International has developed a voluntary standard SA8000 2001, which includes: child labour, health and safety, discrimination and working hours. The British Standards Institute has global accreditation to this standard, but implementation is voluntary.

Societal impacts have not received sufficient consideration

8.3 Further work to clarify the social impacts associated with a greater role for biofuels in the UK energy mix is required. The Partial Regulatory Impact Assessment undertaken by the DfT does not take account of social impacts outside of UK. Data availability may at present be a barrier. Concerns are already being raised in the media[50].

Information is limited

8.4 A brief overview of the literature indicates limited data availability. The most detailed study is by Friends of the Earth, they examined the growing of oil palm for a number of purposes, in Malaysia, Indonesia, and Papua New Guinea. Negative side effects included:

- Health – in Papua New Guinea women have reported significant increases in birth defects, fertility and maternity problems associated with the production of oil palm. In Malaysia – woman working as pesticide sprayers have shown poisoning symptoms including nose bleeds and abdominal ulceration.
- Poor treatment of workers – in Indonesia, plantation wages are typically below the minimum wage and commonly neither working tools nor safety equipment are provided
- Social conflict – there are extensive issues over land rights. In Indonesia indigenous people rarely have land ownership rights and as a result palm oil companies have taken over large tracts of community forests and customary rights land.

8.5 There are clearly links between societal issues and the good governance principle. The emphasis on this principle is on actively promoting effective, participative systems of governance in all levels of society. Issues about social conflict and treatment of workers are relevant.

8.6 **Recommendation - a much better understanding of the social implications, especially overseas, of a UK biofuels policy is essential. The ISO 26000 offers a potential means of reducing social impacts and should be considered further.**

Incorporation of societal impacts within a RTFO

8.7 E4Tech, ECCM and ICEPT research suggests including accreditation on social issues within the RTFO would be difficult. Until social standards have been developed by an acceptable international body such as ISO (International Organisation for Standardisation) acceptance by the World Trade Organisation is unlikely. In the longer term ISO are planning standard guidelines for Social Responsibility (ISO 26000) which is expected in late 2008. Assurance on health and safety standards for the supply of goods is recognised by the WTO.

8.8 The Roundtable on Sustainable Palm oil has recently been established to promote the sustainable production and use of palm oil. Findings from this study could inform the development and implementation of the RTFO.

8.9 We note that the RTFO feasibility study mentions the possibility of a start date of April 2008 and that ISO 26000 is due in the last quarter of 2008: consideration must be given to the launch of the RTFO in late 2008 to allow ISO26000 to be used.

Need for consideration of other ways forward

8.10 Research by Friends of the Earth provides a number of recommendations for palm oil. At the UK government level these include:

- Changes in the legal framework
    - Mandatory Reporting – requiring all UK companies to report annually on the impact of their operations, policies, products and procurement practices on people and the environment both in the UK and abroad.
    - Foreign Direct Liability – to enable affected communities abroad to seek damages in the UK for human rights and environmental abuses resulting directly from the policies, products and procurement practices of UK companies or their overseas subsidiaries.
- To take a lead in reviewing the social and environmental impacts of the international commodity trade
- To strongly support action by the governments of producer countries to ensure that UK companies obey the national law in those countries and ensure that those who do not are prosecuted.

8.11 The SDC recognises that addressing the above recommendations and the issues raised earlier in the section requires cross-government action and action at the EU and international level. However, it is also important to highlight that in setting a 5% biofuels target, which may itself require the use of imported feedstocks, a responsibility lies with DfT to ensure that societal, and other impacts are addressed and minimised.

8.12 **Recommendation - DfT to ensure that data are available to allow road transport fuels suppliers to make decisions that allow them to comply with their corporate social responsibility. A wider cross-government approach to societal impacts associated with different products is necessary.**

Connecting UK Local Supply with National Distribution

8.13 The Renewable Transport Fuel Obligation will be placed on transport fuel suppliers, who operate at the national level. However, in the UK some biofuels will be produced on a small scale at the local level. Although, the Renewable Transport Fuels Obligation will provide 'renewable fuel' certificates to local producers which can be traded, there is the potential that these suppliers could be overlooked. To ensure a genuinely competitive market the DfT may need to introduce further measures.

8.14 **Recommendation: The DfT must work with local producers and the fuel suppliers to develop measures that encourage national fuel suppliers to source biofuels from all accredited suppliers.**

9 Achieving a sustainable economy

9.1 The emphasis within the principle is on building a strong, stable and sustainable economy which provides prosperity and opportunities for all, and in which environmental and social costs fall on those who impose them and efficient resource use. The key themes associated with biofuels are: energy security; costs of implementation and benefits predominantly in terms of potential job creation.

Energy Security

9.2 UK road transport is reliant on oil. The UK is currently a net exporter of oil but exports have been falling over the past couple of years and imports increasing. It is suggested that by 2010 the UK will be a net importer of oil. The decrease in oil supplies and increasing reliance on a small number of countries as resources become scarcer raises energy security concerns. While biofuels have a potential role in increasing energy security, it is essential that the efficient use of vehicles and behavioural change measures are also considered[51]. These measures will ensure efficient use of existing oil supplies and biofuels and have significant carbon emission reduction benefits. The SDC considers the measures below and discusses the importance of a longer term strategy.

Efficient use of fuel

9.3 In recent years there have been significant improvements in vehicle fuel efficiency, however these have been offset by consumers purchasing larger vehicles and vehicles with extras such as air conditioning. Measures to encourage people to purchase more fuel efficient vehicles are necessary. Our research suggests that widening of VED could have a significant impact[52]. Other measures include the use of rebates, increases in fuel duty and availability of information on the costs associated with running a less efficient vehicle. Measures to ensure that vehicles are driven more efficiently are also necessary, this could include the stricter enforcement of existing speeds limits, the introduction of lower motorway speed limits, and information on measures to ensure fuel efficient driving. It should be noted that oil price increases may also increase the uptake of more fuel efficient vehicles and driving practices.

The need for measures, which facilitate behavioural change

9.4 Research for the Department for Transport[53] suggests that with a significant expansion of measures to encourage more sustainable travel, including:

- travel plans
- public transport information and planning
- travel awareness campaigns
- car clubs
- teleworking and teleconferencing

A nationwide reduction in all traffic of approximately 11% could be achieved. This traffic reduction would lead to a decrease in fuel use, potentially extending existing UK supplies. These sustainable travel measures would also facilitate a longer term move away from current patterns of low occupancy private vehicles, which we consider an essential component of future energy security.

9.5 The introduction of these measures will have further benefits in terms of congestion reduction, air quality improvements, carbon emission reduction, and benefits in terms of social inclusion.

9.6 The research highlights the need to 'lock in' the benefits through appropriate supportive measures these include:

- the re-allocation of road capacity
- parking control
- road pricing
- other traffic restraint measures

9.7 A national road pricing scheme is currently being considered, a revenue neutral scheme has the potential to increase and reduce carbon emissions[54]. It is essential that any scheme is either accompanied by measures to reduce carbon emissions or is designed to encourage people to purchase more fuel efficient cars

Biofuels to be considered within a long term strategy

9.8 The role of demand management, vehicle efficiency, biofuels and other alternative fuels need to be considered within a longer term strategy. If there is an emphasis on biofuels, whether independently or as part of a move to a hydrogen economy, then there is the potential for the UK to diversify its sources for biofuel imports and place a greater emphasis on UK sources.

9.9 **Recommendation – a longer term strategy on energy security and transport is necessary. This should consider alternative fuels, efficient vehicles and behavioural change.**

Costs

9.10 Decades of perverse subsidies and the licensed externalisation of costs have contributed to low energy prices. The cumulative affect of these failures has been perversely low fossil fuel prices, and so neither producers nor consumers are required to pay for the full cost of their actions. The environmental cost of energy use in the UK will be paid for by future generations, globally, in coping with the effects of climate change. This transfer of costs is contrary to the principles of sustainable development and may be seen as a significant subsidy for the present-day industry and consumers. It also creates a decidedly un-level playing field when comparing the costs of action on climate change against alternative options based on continued use of fossil fuels with their externalized climate change costs.

9.11 As such the true costs of transport choices are hidden. Excluding them overstates the contribution that transport makes to the UK economy, and understates the costs imposed in other areas of the economy required to address them. The extent to which transport costs remain external significantly influences the appraisal of costs and benefits.

9.12 At present, the cost of the majority of biofuels is higher than for conventional fuels. It is also clear that if the cost of oil increases then the differential decreases. The SDC considers some key issues below.

Costs associated with biofuels

9.13 To help offset the current

differential there is a 20 pence per litre duty incentive. This results in a short-term loss of revenue for the Treasury. Even with this incentive the biofuel blend may be more expensive than conventional fuels, if so, the cost is met by the consumer. The Renewable Transport Fuels Obligation may result in additional costs which would all consumers would have to pay. The costs will depend on the percentage of the blend, the price of oil, and the administrative costs associated with the setting up of the RTFO. The RTFO would use a buyout mechanism, which could ensure that the additional costs of supplying renewable fuels did not reach unacceptable limits.

9.14 **Recommendation – the use of biofuels in conventional fuels presents an opportunity for engagement with consumers about climate change and further sustainability issues.**

9.15 Biofuels may not be the most resource efficient use of biomass both in terms of cost of carbon and the total volume of carbon saved using current figures[55]. Consideration of a wider strategic plan for biofuels and biomass use in the UK is necessary, especially for discussion about targets higher than the 5% for the RTFO.

9.16 **Recommendation – a strategic view of the role that biomass and biofuels will play in meeting future energy needs is necessary, and this needs to link into a wider assessment of land uses including the role of food and non-food crops and land for building.**

Employment opportunities

9.17 Biofuels could create employment opportunities. Key topics are briefly discussed below.

National level

9.18 The introduction of biofuels could potentially lead to employment opportunities. For biodiesel it is suggested that approximately two on-farm jobs could be created per 1000 tonnes of biodiesel and a 100,000 tonne biodiesel plant would employ approximately 62 staff in the processing and blending industries. For bioethanol it is suggested that around 5.5 jobs are created per 1000 tonnes of bioethanol produced from wheat and sugar beet. While a 100,000 tonne bioethanol plant employs 50-55 staff plus a further 16-28 in fuel blending and transport.

9.19 However alternative uses of the crop may produce greater benefits to the rural community. For example there may be greater financial benefits associated with short-rotation coppice growth for electricity generation rather than oilseed rape cultivated for biodiesel production.

International level

9.20 In Brazil it is estimated that production of Bioethanol is responsible for between 0.7 and 1 million direct jobs and 2 million indirect jobs. It is estimated that 200,000 barrels of gasoline are replaced per day and that there are hard currency savings of 1.8 billion US dollars/year. However, this is a result of extensive subsidy. Research also suggests that the growing of sugar cane in Brazil has led to altered migration patterns and that this has had impacts on Brazil's society. In Indonesia, the oil palm sector employs around 1% of the workforce.

9.21 Recommendation – further research into the employment opportunities associated with biofuels in the UK and at the International level is necessary.

10 Conclusions

10.1 While biofuels can and should play an increasingly important role in the UK fuel mix for transport, their introduction must be carefully managed to avoid undesirable unplanned outcomes. Increasing biofuels above the 5% target is likely to cause increasing difficulties with some or all of the five guiding principles of sustainable development especially with the increasing use of primary crops as the main feedstock.

10.2 Our concerns are:

- The greenhouse gas emission savings anticipated through the use of biofuels may not be achieved
- In development of current policy at the EU and UK level further effort is required to guard against undesirable impacts of biofuel production on biodiversity and society
- Issues over data availability may be used as an excuse for delaying action to resolve above issues

10.3 Our recommendations are:

- The RTFO should be designed from the outset with graduated incentives to encourage the use of lower carbon feedstocks
- Waste products are a key future feedstock for biofuels: they offer high carbon reduction and make use of products that are currently non-productive
- Energy efficiency and demand management measures are required to make sure that fuel-switching does lead to absolute reductions on greenhouse gas emissions from transport
- The carbon savings associated with biofuels need to be quantified across the whole life cycle and validated through an accreditation scheme. At present it is not possible to guarantee the purported 1 MtC per annum saving associated with a 5% biofuels target.
- Detailed consideration needs to be given to the impacts on biodiversity and social impacts / governance issues associated with biofuels both in the UK and overseas. In association with the Renewable Transport Fuels Obligation an assurance scheme and use of ISO 26000 are potential ways forward. Cross government working on other measures is also necessary. In the future development of biofuels policy these issues need to receive much greater attention.

10.4 This note - the methodology, our concerns and recommendations is a starting point for discussion with the Department for Transport on how all aspects of sustainability can be encompassed with policy on biofuels.

SDC Recommendations

Chapter 3

Recommendation: DfT and other government departments to ensure that measures to encourage the uptake of biofuels help bring to market the technologies required to make full use of agricultural and forest residues as feedstocks. The RTFO should be designed with graduated incentives for lower carbon fuels from the outset. A volume-based RTFO is unlikely to incentivise carbon-savings. (Paragraph 3.10).

Chapter 7

Recommendation: The DfT must validate the assumption for the RTFO that biofuels will result in a 50% reduction in emissions, based on whole life cycle analysis. (Paragraph 7.11)

Recommendation: measures to ensure that either direct or indirect deforestation does not occur should be an essential component of the RTFO. (Paragraph 7.15).

Recommendation: Future research to clarify the potential greenhouse gas savings associated with:

i) Production of biofuels using a variety of farming methods (organic to intensive)
ii) Organic and non-organic methods for all crops (food and non-food)

(Paragraph 7.21)

Recommendation: Energy requirements and emissions should be allocated to co-products, and emissions saved by use of these co-products should also be considered. (Paragraph 7.24)

Recommendation: The DfT must assess the impact of the RTFO on the development and uptake of new technologies. Steps must be taken to ensure that the appropriate policy and financial support is available for those technologies that will make full use of potential biofuel feedstocks and save most carbon. This is the basis of our recommendation that the RTFO is graduated to reward greater carbon savings. (Paragraph 7.26)

Recommendation: to make full use of the opportunity through the expanding biofuels market to encourage the development of small scale and distributed electricity generation as recommended in the Energy White Paper (2003). (Paragraph 7.29)

Recommendations: The DfT must ensure that complex issues for example the potential for deforestation are addressed within RTFO mandatory reporting. Incentives linked to the greenhouse gas emissions of biofuels must be introduced from the outset. (Paragraph 7.36)

Recommendation: DfT and Defra to promote the uptake of waste vegetable oils as biofuels provided they meet air quality objectives. (Paragraph 7.38)

Recommendation: For a biofuels policy to be sustainable impacts on biodiversity need to be addressed and minimised. Care is required to make sure that the uptake of biofuels crops does not unpick the environmental and conservation objectives now built into agricultural and forestry objectives. (Paragraph 7.44).

Recommendation: a better understanding of the impact of increased demand for biofuels would have on deforestation or other loss of biodiversity is an essential part of any scheme to promote the uptake of biofuels. (Paragraph 7.46).

Recommendation – production of biofuel crops should be guided by local environmental limits including those for soil, air and water quality, landscape change and water resources. Further work is required to clarify these limits. The use of an accreditation scheme will help to reduce impacts at the International and National Level. (Paragraph 7.54).

Recommendation - a much better understanding of the social implications, especially overseas, of a UK biofuels policy is essential. The ISO 26000 offers a potential means of reducing social impacts and should be considered further. (Paragraph 8.6).

Recommendation - DfT to ensure that data are available to allow road transport fuels suppliers to make decisions that allow them to comply with their corporate social responsibility. A wider cross-government approach to societal impacts associated with different products is necessary. (Paragraph 8.12).

Recommendation: The DfT must work with local producers and the fuel suppliers to develop measures that encourage national fuel suppliers to source biofuels from all accredited suppliers. (Paragraph 8.14)

Recommendation – a longer term strategy on energy security and transport is necessary. This should consider alternative fuels, efficient vehicles and behavioural change. (Paragraph 9.9).

Recommendation – the use of biofuels in conventional fuels presents an opportunity for engagement with consumers about climate change and further sustainability issues. (Paragraph 9.14)

Recommendation – a strategic view of the role that biomass and biofuels will play in meeting future energy needs is necessary, and this needs to link into a wider assessment of land uses including the role of food and non-food crops and land for building. (Paragraph 9.16).

Recommendation – further research into the employment opportunities associated with biofuels in the UK and at the International level is necessary. (Paragraph 9.21).

Annex 1 - Energy production from different feedstocks (PJ)

Uses table 3.3 from Woods and Bauen. The impact of straw is removed.

Oil seed rape

Woods and Bauen assumes 47.3 PJ for 0.597 Mha this is equal to 0.0000792 PJ per ha. Assuming 80,000 ha then 6.34 PJ. Assuming 537,000 all current land for oil seed rape then 42.5. Assuming set-aside used 681,000ha then 53.96.

Sugar beet

Woods and Bauen suggest 124 PJ for 0.597 Mha (does not include straw) this is equal to 0.000208 PJ per ha. Assuming land currently used for food purposes is used to grow sugar beet then 205,000 ha then 42.64 PJ.

Wheat

Woods and Bauen suggest 70.8 PJ for 0.597 Mha this is equal to 0.000119 PJ per ha. We export 3 million tonnes of wheat from 350,000 ha. Therefore 41.65 PJ.

Lignocellulosic (short rotation coppice)

Woods and Bauen suggest 108 PJ for 0.597 Mha this is equal to 0.000181 PJ per ha. If replaced set-aside with 681,000 ha replaced then energy production would be 123.26 PJ

Lignocellulosic (miscanthus)

Woods and Bauen suggest 161 PJ for 0.597 Mha this is equivalent to 0.00027 PJ per ha. If replaced set-aside, with 681,000 ha replaced then energy production would be 183.65 PJ.

Waste Vegetable Oils

Woods and Bauen suggests that a conservative estimate of the total recoverable waste vegetable oil resource in the UK is between 7.2 and 14.4 PJ. Based on 200,000 and 400,000 tonnes respectively. One tonne is 0.000036 PJ. The NFU suggests that waste vegetable oil currently produces around 60,000 tonnes, this is equivalent to 2.16 PJ.

References

[1] Department of Trade and Industry 2003. Energy White Paper: Our Energy Future - creating a low carbon economy

[2] HM Treasury (2006) Budget 2006 http://www.hm-treasury.gov.uk/budget/budget_06/bud_bud06_index.cfm

[3] HM Treasury (2005) Budget 2005 http://www.hm-treasury.gov.uk/budget/budget_05/budget_report/bud_bud05_report.cfm

[4] Woods J. and Bauen A. (2003) Technology status review and carbon abatement potential of renewable transport fuels in the UK A report for the DTI

[5] Forum for the Future (2005) Farms for the Future: How farming is meeting the challenge of Sustainability.

[6] Choren Industries GmbH (2003). The Carbo-V Process in Woods and Bauen (2003)

[7] Gilliland J. personal communication 2005.

[8] Volvo/Ducent in Woods and Bauen (2003)

[9] British Association for Bio Fuels and Oils (2003) Response to the Department for Transport Consultation on Ultra Low Carbon Transport – hydrogen and biofuels

[10]British Sugar press release http://www.britishsugar.co.uk/RVEa326524311fa46e3827a286a3c57aaaa,,.aspx

[11] Otte et 2000 in IEA. IEA (2004) Biofuels for Transport: An International Perspective, OECD, Paris
The Newest Silverado: A Production Feasible Ethanol (E85) Conversion by the University of Nebraska. Lincoln Department of Mechanical Engineering & SAE, Inc.

[12] AAA in IEA (2004) AAA, 2002
AAA Response to the Environment Australia Issues Paper (see EIAP, 2001), "Setting the Ethanol Limit in Petrol", http://www.aaa.asn.au/submis/2002/Ethanol_March02.pdf
ADEME, 2003, Journée Débat Biocarburants,

[13] Forum (2000) in IEA (2004)
Forum, 2000, Forum on Ethanol Blending in Gasoline in the Northeast and Mid Atlantic, June 27, http://www.nrbp.org/pdfs/pub23.pdf

[14] Moreira, (2003) in IEA (2004)
Moreira, J.R. (2003) Personal Contact with Prof. José Roberta Moreira, Brazilian Biomass Reference Centre – CENBIO Rua Francsico Dias Velho

[15] Bauen A. (2006) Biofuels – An Overview. Presentation on the Stern Review Team and DfT Seminar.

[16] Turley D, Ceddia G, Bullard M, Martin D Liquid Biofuels – industry support, cost of carbon savings and agricultural implications. Report prepared for Defra organic farming and industrial crops division

[17] E4 Tech (2003) Liquid Biofuels and Hydrogen Fuels Renewable Sources in the UK to 2050: a technical analysis. An assessment of the Implications of achieving ultra low carbon road transport. A report to the Department for Transport
http://www.dti.gov.uk/energy/sepn/h2biofuelsassessment.shtml

[18] DfT (2005) Partial Regulatory Impact Assessment Biofuels
http://www.dft.gov.uk/stellent/groups/dft_roads/documents/pdf/dft_roads_p

df_610330.pdf

[19] HM Government (2005) Securing the Future - Delivering the UK Sustainable Development Strategy

[20] UK Government and Devolved Administrations Framework

[21] Department of the Environment, Transport and the Regions (2000) Climate Change the UK Programme

[22] Her Majesty's Treasury (2004) Spending Review Public Service Agreements

[23] Cleaner Transport Forum, Institute for European Environmental Policy, National Society for Clean Air (2004) Expert Paper on the Global Impacts of Road Transport Biofuels – A Contribution to the Government's Analysis http://www.nsca.org.uk/assets/Biofuelsexperts.pdf

[24] Sheffield Hallam University Resources Research Unit (2003) Carbon and Energy Balances for a Range of Biofuels Options. http://www.shu.ac.uk/rru/projects/biofuels/biofuels.html

[25] CONCAWE, EUCAR and the Joint Research Centre (2003) Well-to-Wheels Analysis of Future Automative Fuels and Powertrains in the European Context

[26] Low Carbon Vehicle Partnership (2004) A report by the LowCVP Fuels Working Group http://www.lowcvp.org.uk/uploaded/documents/Biofuels_WTW_final_report.pdf

[27] E4Tech, ECCM and Themba (2006) A Methodology and Tool for Calculating the Carbon Intensity of Biofuels. Draft Final Report http://www.lowcvp.org.uk/uploaded/documents/FWG-P-06-03%20Carbon%20Certification%20Methodology%20-%20final%20draft.pdf

[28] E4Tech, Edinburgh Centre for Carbon Management ltd, Imperial Centre for Energy Policy and Technology (2005) Feasibility Study on Certification for a Renewable Transport Fuel Obligation

[29] Mortimer N.D., Cormack P., Elsayed M.A. and Horne R.E. (2003) Evaluation of the Comparative Energy, Global Warming and Socio Economic Costs and Benefits of Biodiesel http://www.defra.gov.uk/farm/acu/research/reports/nf0422.pdf

[30] Lang S. (2005) http://www.news.cornell.edu/stories/July05/organic.farm.vs.other.ssl.html

[31] ADAS (2005) Stockless Organic http://www.stocklessorganic.co.uk/stockless/beet.html

[32] Biomass Task Force (2005) Report to Government

[33] Faleiros G. F. (2005) Public Policies and the Ecological Modernization of Ethanol Production in the State of São Paulo, Brazil. Dissertation for MA Geography, King's College, London

[34] Climate Care Capital Ltd (2005) Optimising the Design of the RTFO http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_610365.pdf

[35]Millenium Ecosystem Assessment (2005) Ecosystems and Human Well Being – Biodiversity Synthesis http://www.millenniumassessment.org/en/Products.aspx

[36] Convention on Biological Diversity –

2010 Biodiversity Target
http://www.biodiv.org/2010-target/default.asp

[37] EU Habitats Directive (1992) (92/43/EEC)

[38] EU Birds Directive (1979) (79/409/EEC)

[39] Buckingham D.L., Evans A.D., Morris A.J., Orsman C.J., Yaxley R. (1999) Use of Set-aside Land in Winter by Declining Farmland Bird Species in the UK. Bird Study, Volume 46, No2, 1 July 1999 pp. 157-169 (13)

[40] Henderson I.G., Vickery J.A., Fuller R.J. (2000) Summer Birds Abundance and Distribution on Fields on Intensive Arable Farms in England. Ecography 23:50-59

[41] Turley D., McKay H. and Boardman N. (2005) Environmental Impacts of Cereal and Oilseed Rape Cropping in the UK. Report for the Home Grown Cereals Authority

[42] Royal Society for the Protection of Birds (2003) Potential Impacts of Increased Liquid Biofuel Production on Farmland Bird Populations

[43] Friends of the Earth (2003) Greasy Palms - the Social and Ecological Inputs of Large Scale Oil Palm Plantation Development in SouthEast Asia

[44]Dean, W. (1995) With broadax and firebrand : the destruction of the Brazilian Atlantic forest Berkley: University of California Press referenced in Faleiros (2005)

[45] WWF (2005) Sustainability and Biofuels: Lessons from Brazil. Conference of the German Network on Renewable Energies North-South, Bonn 20 June 2005

[46] The Soil Association (2000) The Biodiversity Benefits of Organic Farming http://www.soilassociation.org/web/sa/saweb.nsf/a71fa2b6e2b6d3e980256a6c004542b4/67bff1084a5b1d0880256ae50039d8cb/$FILE/Biodiversity%20Report.pdf

[47] Secretaria do Meio Ambiente de Sao Paulo (2004) *Balanço das emissões de gases efeito estufa na produção e no uso do etanol no Brasil* São Paulo: Governo do Estado de São Paulo in Faleiros 2005

[48] Department for Transport (2004) The Air Quality Impacts of Biofuels

[49] East of England Development Agency The Impact of Creating A Domestic UK Bioethanol Industry

[50] Monbiot G. (2004) The Adoption of Biofuels would be a Humanitarian and Environmental Disaster for the Planet. Guardian Weekly http://www.guardian.co.uk/guardianweekly/story/0,,1363756,00.html

[51] Banister D. and Hickman R. (2005) Visioning and Backcasting for UK Transport Policy
Report for DfT

[52] Sustainable Development Commission (2005) Changes in VED – modelling http://www.sd-commission.org.uk/news/resource_download.php?attach_id=WTHN6B1-PNTQ7GW-VD8P0UH-MZPC5O4

[53] Cairns S., Sloman L., Newson C., Anable J., Kirkbride A., Goodwin P. (2004) Smarter Choices Changing the Way We Travel http://www.dft.gov.uk/stellent/groups/dft_susttravel/documents/page/

dft_susttravel_029722.pdf

[54] IPPR (2003) Putting the Brakes on Climate Change: A Policy Report on Road Transport and Climate Change http://www.ippr.org.uk/ecomm/files/PuttingtheBrakeson.pdf

[55] The Carbon Trust (2005) Biomass Sector Review. Report by Paul Arwas Associates for the Carbon Trust